# The AGS eIPMs

R. Connolly, T. Curcio, C. Dawson, S. Dai, J. Fite, H. Huang, S. Jao, D. Lehn, W. Meng,
R. Michnoff, M. Minty, P. Sampson, R. Smith, T. Summers, S. Tepikian, C. Trabocchi

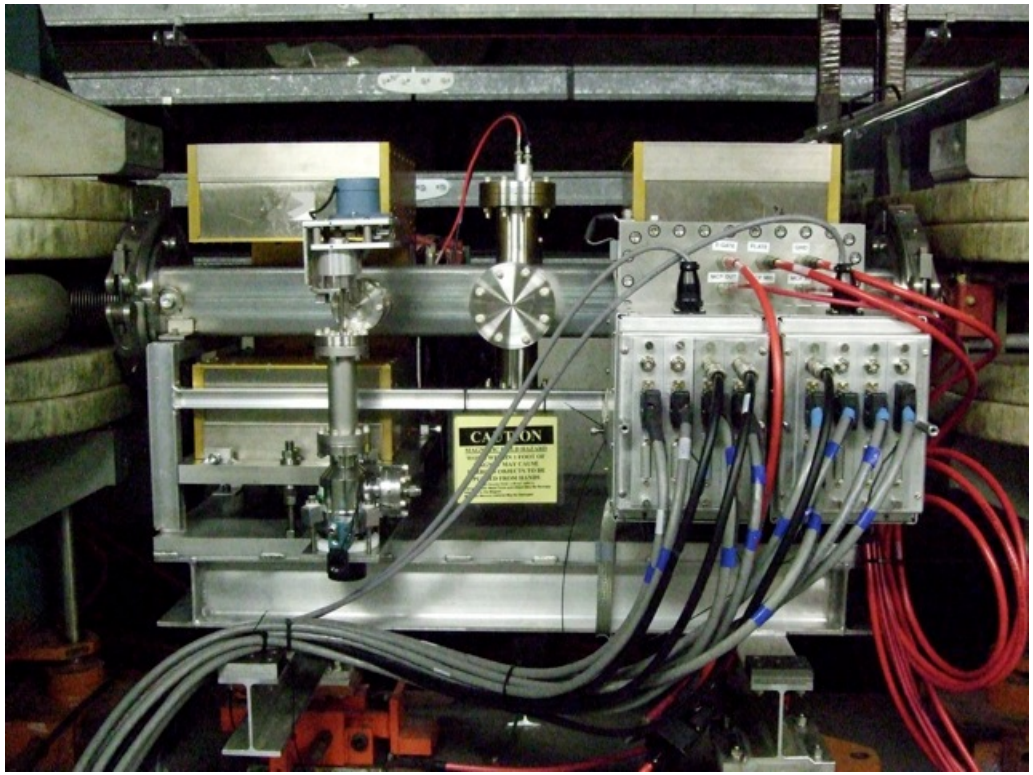
The Ionization Beam Profile Monitors (IPMs) used in RHIC have been developed at BNL in a program that started in 1996.

The current RHIC IPMs are a design from 2009. The prototype of this design was built in 2007, and installed as the YV RHIC detector.

In 2012, both vertical IPMs were removed and replaced with the new desgin. During the past year, the 2007 prototype was reconditioned and installed in the AGS D5 straight section, oriented to measure the horizontal beam profile. The vacuum chamber is the spare RHIC chamber.

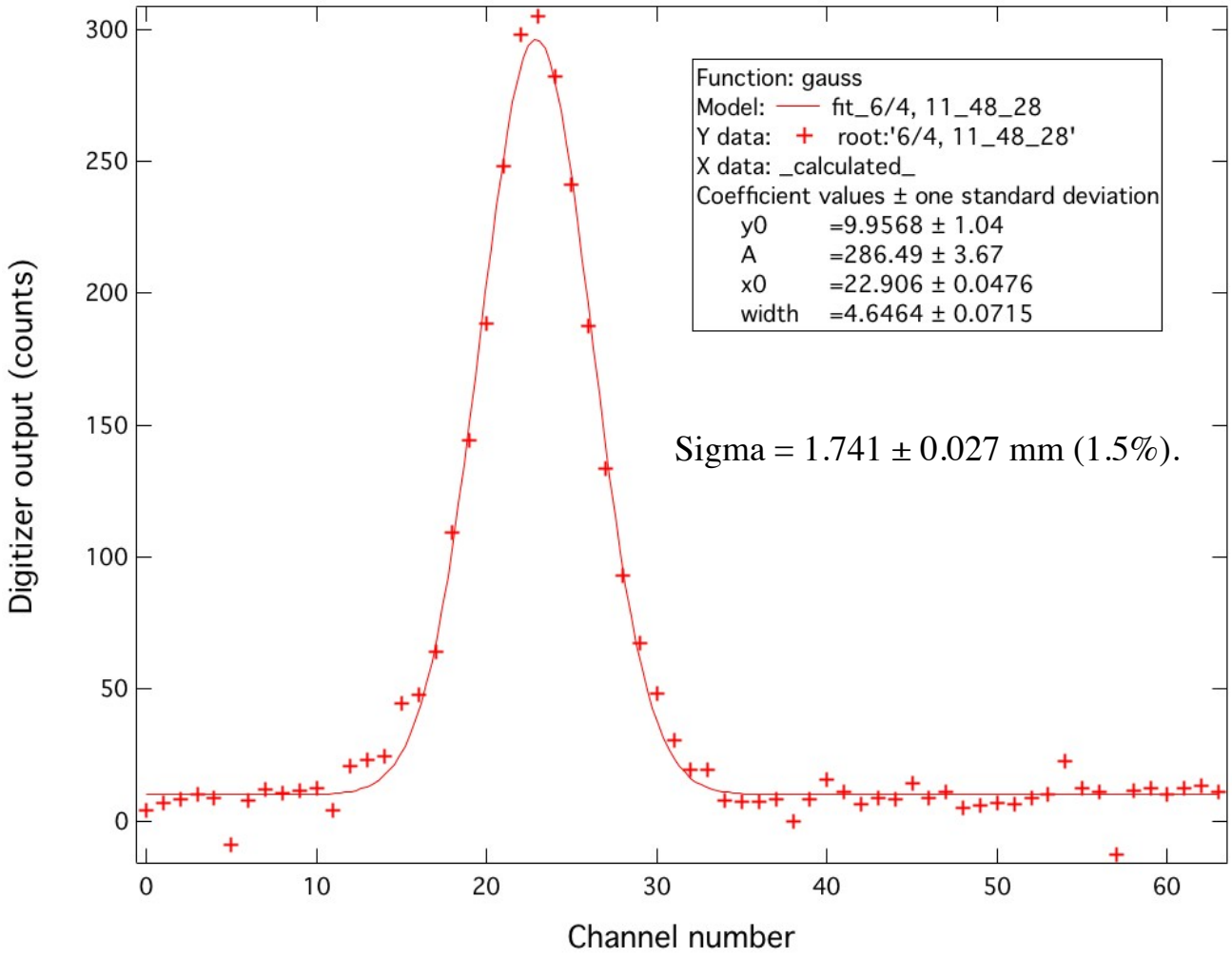
This talk describes the installation, shows commissioning results and describes future work.

Tunnel installation between D5 and D6



Electronics in E10

Profile measured at 281 ms after injection. Amplifier offsets are subtracted in all channels and amplifier gain variations are corrected in channels 1-30.

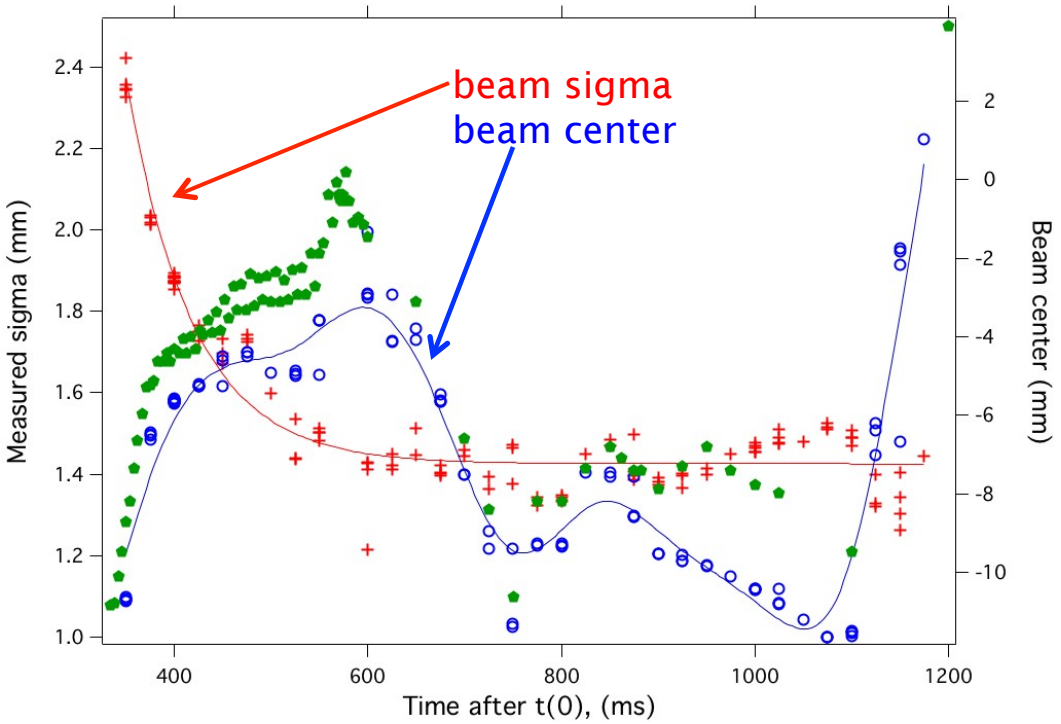


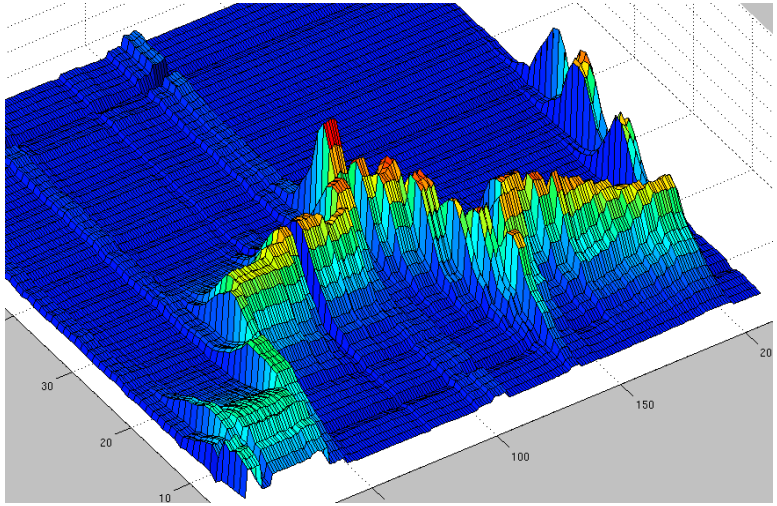
# Orbit stability is a concern

This is a plot of measured beam sigma (red +) and beam center (blue o) vs. time from $t_0$. The D4 horizontal BPM positions are shown in green, solid markers.

When the beam was injected, 148ms after $t_0$, it was outside of the detector measurement aperture. It moved into the measurement aperture at about $t_0$+350ms or 200ms after injection.

The electronics are set at 64 channels, so the beam orbit has to be stabilized on the ramp or the detector has to have wider channels giving poorer resolution.



# Orbit correction experiment

In normal operation the beam was injected outside of the detector measurement aperture.

**Keith** and **Haixin** were able to change the steering to center the beam at injection.

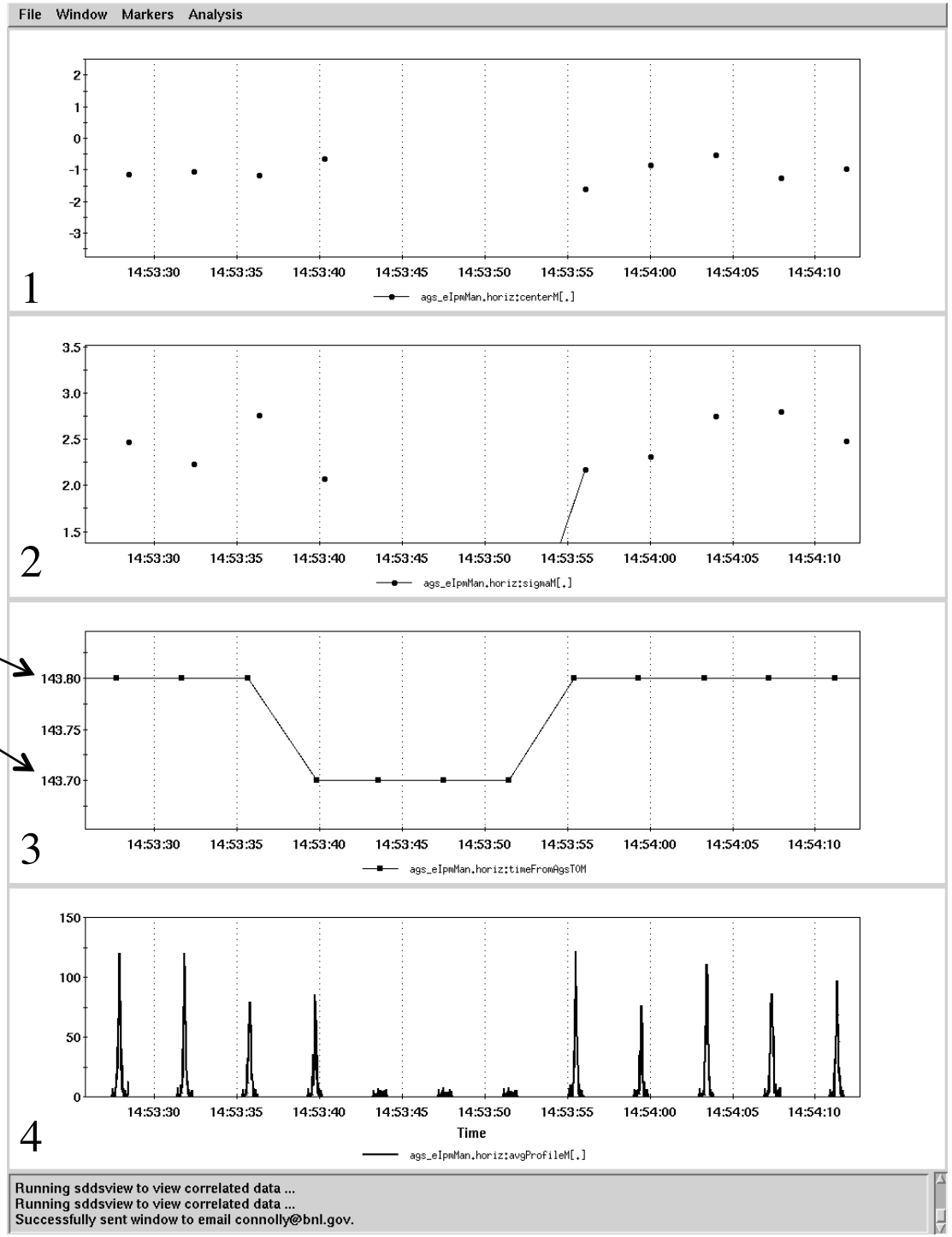
Plot 3 shows the time each measurement was made as a delay from $t_0$.

143.80 ms
143.70 ms

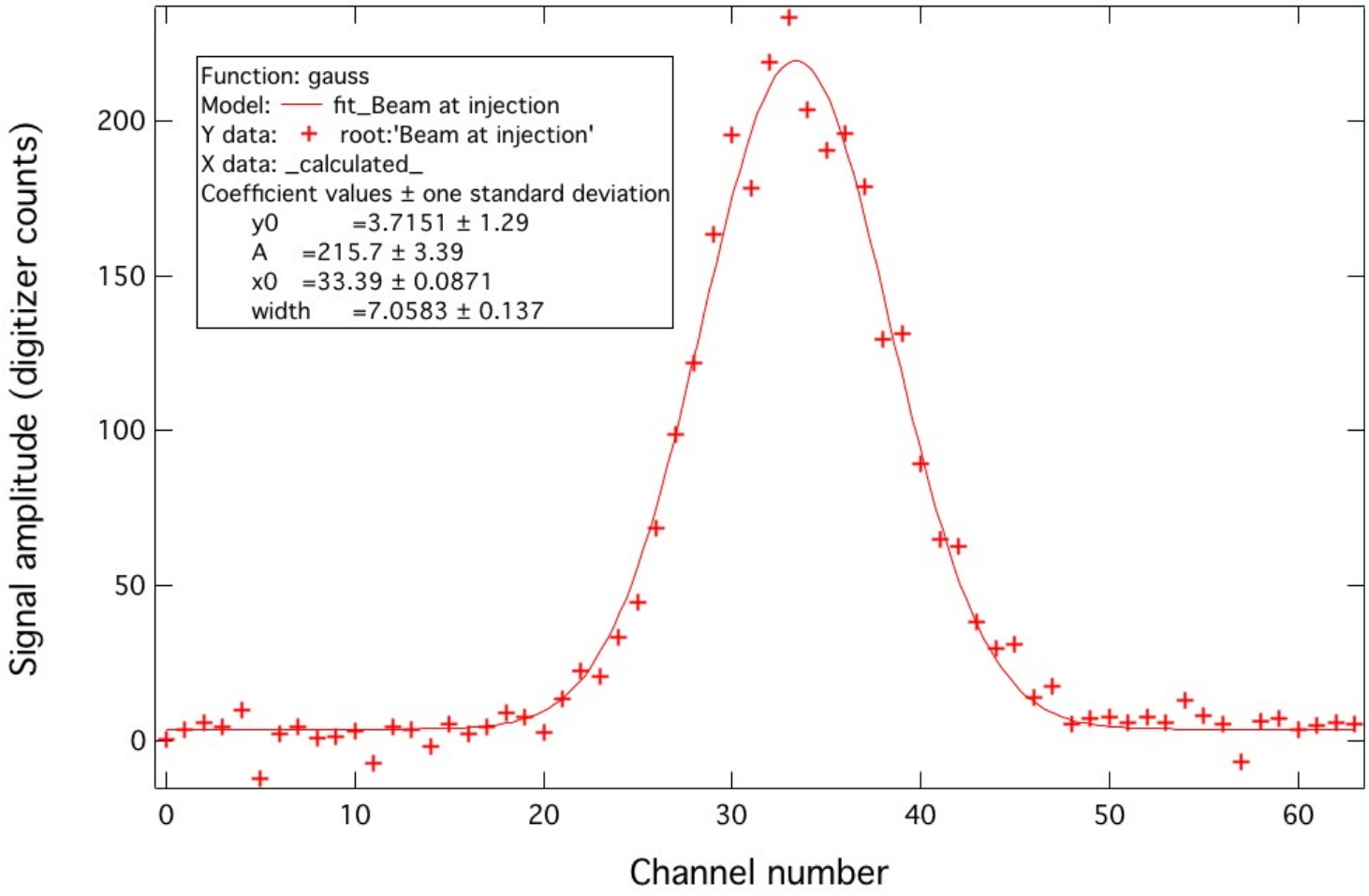
Plot 4 shows profiles measured at the time shown on Plot 3. The beam is injected between 143.7ms and 143.8ms.

Plot 1 shows the beam center position and

Plot 2 shows the measured beam sigmas.



# Centered beam at injection

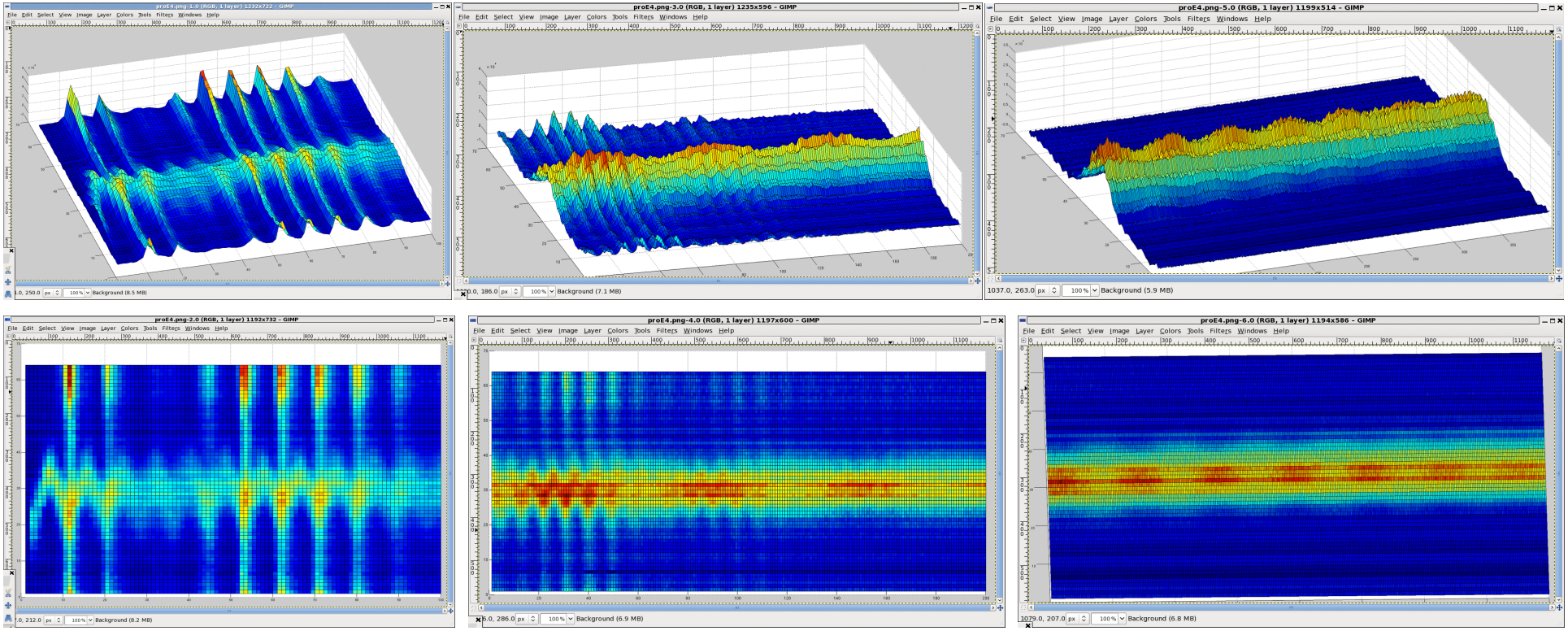


A record of the first 700 turns at injection. Left = 1-100, Middle = 101-300, Right = 301-700.

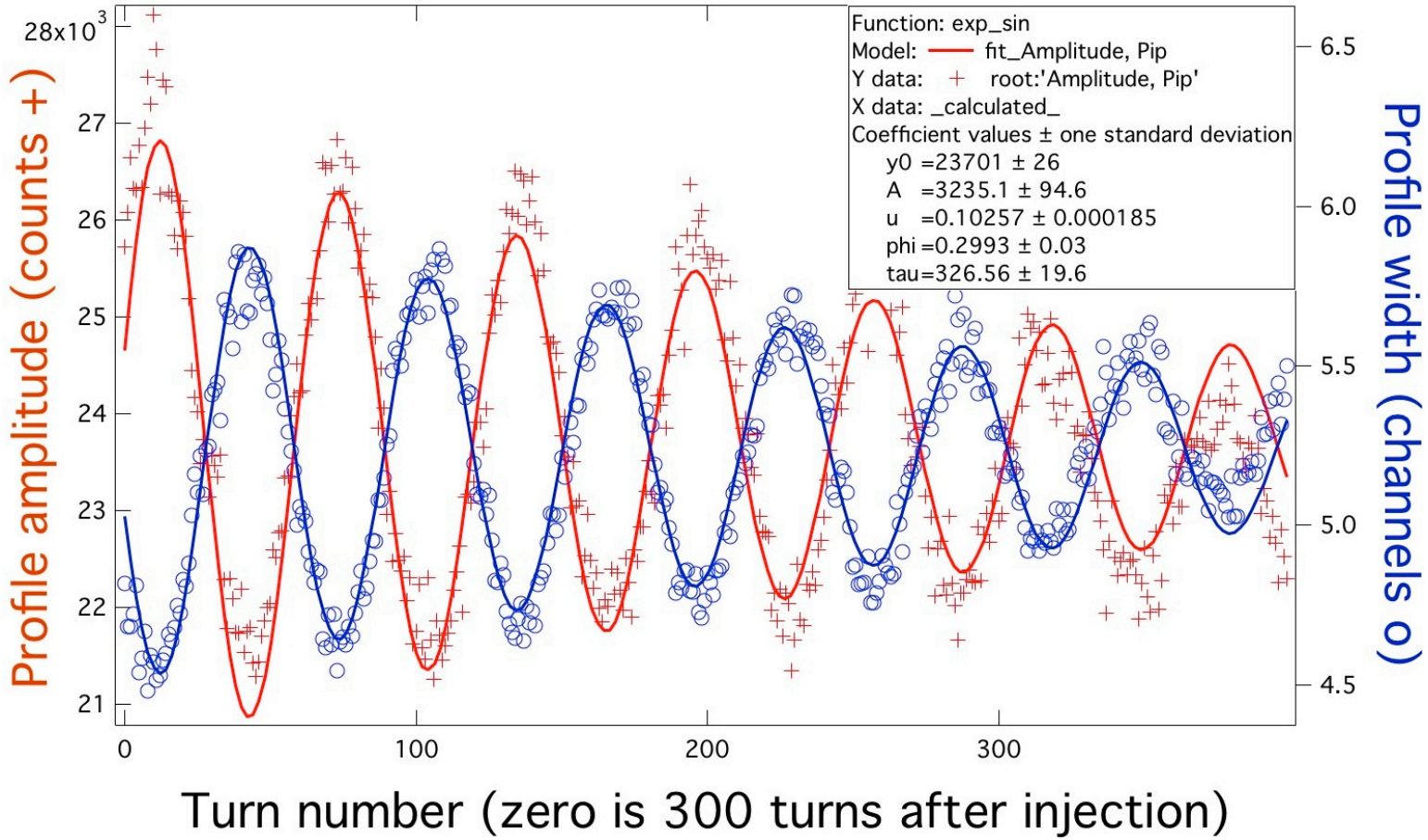
There is a dipole oscillation at injection with a wavelength of about 8.7 turns. This is expected for the horizontal tune which was about 8.85. This oscillation damps out in about 220 turns.

The plot of turns 300-700 shows a width oscillation at the synchrotron oscillation frequency of 61 turns which is exponentially damped with a time constant of 327 turns.

The wings in the transverse distributions during the first 220 turns which appear at the dipole frequency are not understood.



We fit Gaussians to the profiles of the turns 300-700 plot. The bottom plot shows the fit amplitudes (red +) and fit widths (blue o) of these 400 turns with exponentially-damped sine waves fitted to the data.



# 2013 shutdown

## Gas Leak

We have installed a precision gas leak valve to increase the IPM pressure.

## Vacuum Interlock

For equipment protection the HV power supplies are interlocked to the vacuum gauge.

Power Supply Controls and Readback connected to eIPM Manager control

## High Bandwidth Amplifiers

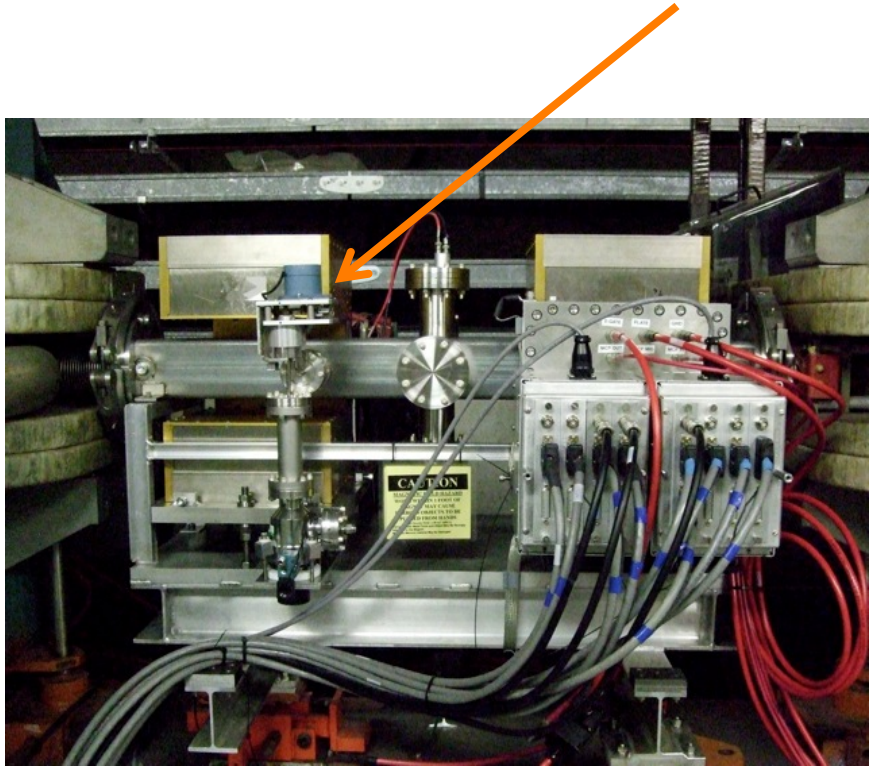
For single-bunch measurements we need to bring the high-bandwidth amplifiers on line.
New shaper amplifiers are being designed and built this summer.

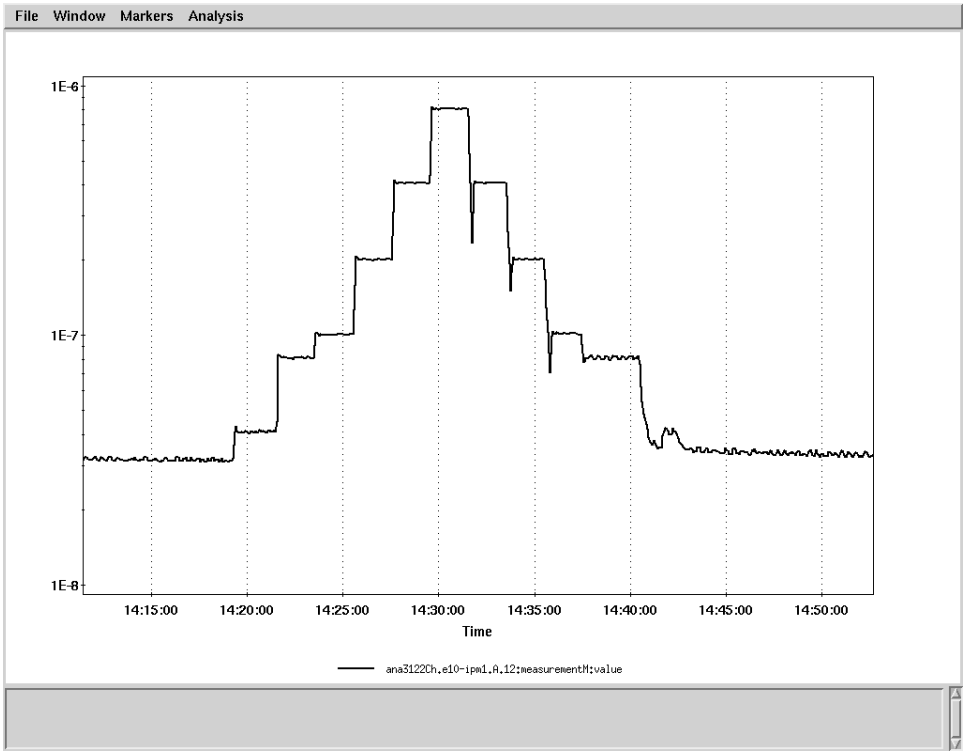
## Beta Function Measurement

A backleg winding will be added to the detector magnet to deflect the beam for beta function measurements. This has been designed.

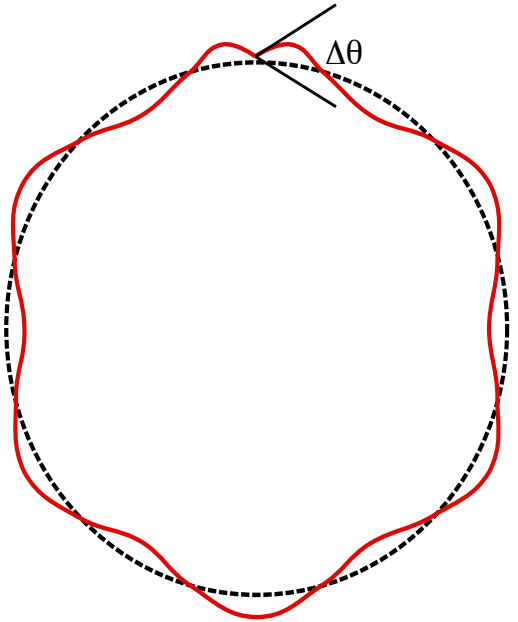
The chamber pressure needs to be raised for single-bunch measurements with protons.

This is a test of the controlled leak valve.





# Measuring β function at IPM

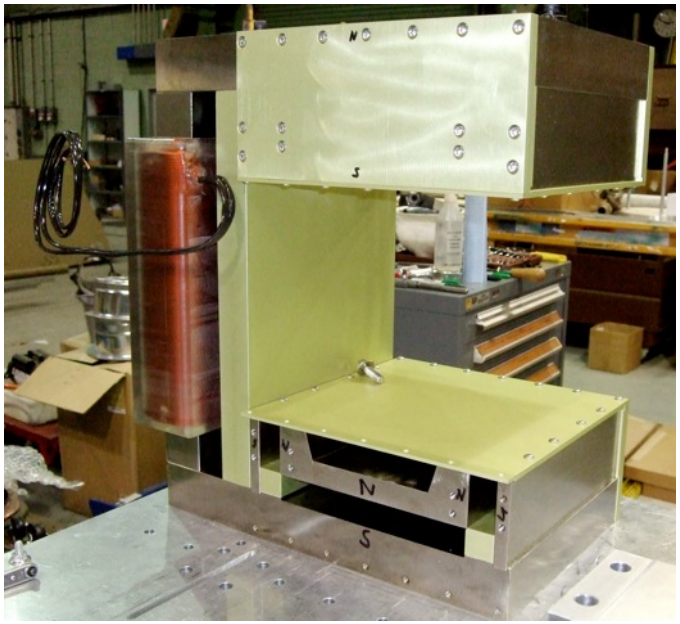



Placing an angular deflection, Δθ, in the closed orbit at location Z=0 creates a new orbit whose distance from the original closed orbit, x(s), varies approximately sinusoidally with s.

If we know the deflection angle and can measure the displacement at the deflection location the beta function at the deflection location is,

Here β(0) is the beta function at the deflection location, Q is the tune.

$$\beta(0) = \frac{2x(0)}{\Delta\theta}\tan(\pi Q)$$



Vertical IPM magnet assembly showing backleg winding for beta function measurement

# SUMMARY

A vertical IPM is being built for installation at D15. This will require a larger physical aperture to accommodate horizontal beam motion.

We will keep the channel spacing at 0.53mm to maintain the current resolution. The beam orbit will be stabilized at the eIPM.

The eIPM will give single-bunch profiles with heavy ions but will require a pressure bump of $\sim 10^{-8}$Torr for protons.

We plan two measurement modes,

An average of 100-1000 turns, taken at 10-20ms intervals. These will be displayed as a mountain range similar to the present IPM application.

A sequence of turn-by-turn profiles of one bunch. This sequence will be 100-1000 turns long and can be triggered at any point in the beam cycle.

## Beta function measurement

If the backleg winding proves successful, we should consider adding this feature to the RHIC IPMs when new IPM magnets are built. We will need 3 times the number of Ampere turns for RHIC